March 7, 2008

To: Joseph P. Hirl
From: Kermit D. Lopez
Re: 10/748,546

Follow up -- Re: proposed changes leading to allowance

We agree with your suggested changes to the claims leading to allowance. We propose a set of claim amendments (see below) that are consistent with your proposed changes, with a few minor changes/amendments to correct antecedent basis and consistency in claim language (e.g., "comprising" vs. comprises, said at least one perceptron, etc.). There were some slight changes to claim 39, for the sake of consistency.

Additionally, we do not see any 102/103 issues concerning USPN 6,536,106 and Mehrotra, etc given the lack of teaching of neural networks / liquid state machine in USPN 6,536,106 and the lack of a teaching of liquid state machine and physical/artificial neural networks in Mehrotra (which deals with algorithms and simulations rather than actual physical devices).

We are agreeable to an Examiner's amendment to make these changes leading to an allowance. If you have any other questions or concerns, please let me know.

PROPOSED CLAIM AMENDMENTS

Amend claims 21, 25, 33, 39 and cancel claims 23, 24 as follows:

1-20 (Previously Cancelled)

21. (Currently Amended) An electromechanical liquid state machine utilizing nanotechnology, comprising:

at least one pre-synaptic electrode and at least one post-synaptic electrode having a connection gap therebetween;

a liquid dielectric solution comprising a mixture of a plurality of nanoconductors and a liquid dielectric solvent, wherein said plurality of nanoconductors are located in and free to move about within said liquid dielectric solution, said liquid dielectric solution disposed in said connection gap between said at least one pre-synaptic electrode and said at least one post-synaptic electrode; and

a mechanism for applying an electric field across said connection gap, said mechanism electrically connected to said at least one pre-synaptic electrode and said at least one post-synaptic electrode, whereby said electric field induces a dipole in each nanoconductor among said plurality of nanoconductors only when said plurality of nanoconductors is located within said liquid dielectric solution, thereby aligning said plurality of nanoconductors within said liquid dielectric solution and attracting said plurality of nanoconductors to said connection gap in order to provide to neural network nanoconnections of a connection network between said at least one pre-synaptic electrode and said at least one post-synaptic electrode within said liquid dielectric solution, said connection network, said liquid dielectric solution, said plurality of nanoconductors, said at least one pre-synaptic electrode and said at least one post-synaptic electrodes electromechanically operable in combination with one another to comprise said electromechanical-based liquid state machine, which stores via patterns of neural activations of said neural network nanoconnections, a recent past history of said electromechanical-based liquid state machine, wherein at least one neural circuit thereof comprises a plurality of neural network connections and at least one perceptron adjusting at least one synaptic weight to produce a predetermined output.

22. (Previously Amended) The liquid state machine of claim 21 wherein the more nanoconductors among said plurality of nanoconductors that align as said electric field is applied across said connection gap, the stronger said neural network nanoconnections become and wherein neural network nanoconnections s that are not utilized dissolve back into said liquid dielectric solution.

23. (Cancelled)
24. (Cancelled)

25. (Currently Amended) The liquid state machine of claim 21 ~~24~~ wherein said at least one perceptron comprises a read-out neuron that generates a linear mapping between said at least one neural circuit within said liquid state machine and an output of said read-out neuron.

26. (Previously Amended) The liquid state machine of claim 21 wherein said at least one pre-synaptic electrode is located perpendicular to said at least one post-synaptic electrode and said electric field is located and applied perpendicular to said connection gap.

27. (Previously Amended) The liquid state machine of claim 26 wherein said at least one pre-synaptic electrode and said at least one post-synaptic electrode are located adjacent one another in a near-crossing configuration.

28. (Previously Amended) The liquid state machine of claim 21 further comprising a supervised learning mechanism associated with said liquid state machine, whereby connections strengths of said neural network nanoconnections within said connection gap are determined by pre-synaptic

and post-synaptic activity respectively associated with said at least one pre-synaptic electrode and said at least one post-synaptic electrode associated with said connection gap.

29. (Previously Amended) The liquid state machine of claim 28 wherein said liquid state machine comprises a supervised learning mechanism.

30. (Previously Amended) The liquid state machine of claim 29 wherein said supervised learning mechanism comprises at least one perceptron.

31. (Previously Amended) The liquid state machine of claim 22 further comprising a physical neural network comprising at least one connection network associated with at least one neuron-like node wherein said at least one connection network comprises a plurality of said neural network nanoconnections, including a plurality of interconnected nanoconductors.

32. (Previously Amended) The liquid state machine of claim 31 wherein:

each nanoconductor of said plurality of interconnected nanoconductors experiences an increase in alignment in accordance with an increase or a decrease in said electric field, a frequency of said electric field, or a combination thereof;

wherein nanoconductors of said plurality of interconnected nanoconductors that are utilized most frequently by said at least one neuron-like node become stronger with each use thereof;

and wherein nanoconductors of said plurality of interconnected nanoconductors that are utilized least frequently become increasingly weak and eventually become unaligned.

33. (Currently Amended) The liquid state machine of claim 31 further comprising a plurality of perceptrons P_1 to P_n that are configured to permit said plurality of perceptrons P_1 to P_n to accept ~~make~~ random connections into said liquid state machine associated with said physical neural network.

34. (Previously Amended) The liquid state machine of claim 21 further comprising:

a gate located adjacent said connection gap;

an insulator located between said gate and said connection gap;

a logic circuit located to said gate; and

wherein said at least one pre-synaptic electrode comprises a source and said at least one post-synaptic electrode comprises a drain.

35. (Previously Amended) The liquid state machine of claim 34 wherein said plurality of nanoconductors comprises DNA.

36. (Previously Amended) The liquid state machine of claim 22 wherein said plurality of nanoconductors comprises carbon nanotubes.

37. (Previously Amended) The liquid state machine of claim 36 wherein said electric field comprises an AC field across said connection gap, thereby strengthening or weakening said neural network nanoconnections in order to accomplish a Spike-Timing Dependent-Plasticity (STDP) rule-based operation.

38. (Previously Amended) An electromechanical liquid state machine based on nanotechnology, comprising:

a liquid dielectric solution composed of a plurality of nanoconductors and a liquid dielectric solvent;

at least one pre-synaptic electrode and at least one post-synaptic electrode having a connection gap therebetween, wherein said liquid dielectric solution is disposed in said connection gap;

a mechanism for providing a dielectrophoretic force that permits nanoconductors among said plurality of nanoconductors align to form neural network nanoconnections between said pre-synaptic and post-synaptic electrodes within said liquid dielectric solution thereby providing a liquid state machine that stores via patterns of neural activations, a recent past history of said liquid state machine; and

a plurality of perceptrons in communication with said liquid state machine and said physical neural network, wherein said plurality of perceptrons extracts at least one state of said liquid state machine from said liquid state machine.

39. (Currently Amended) The liquid state machine of claim 38 wherein at least one perceptron among said plurality of perceptrons ~~said perceptron~~ comprises a read-out neuron that provides a linear mapping between at least one neural circuit within said liquid state machine and an output of said read-out neuron.

40. (Previously Amended) A liquid state machine based on nanotechnology comprising:

a physical neural network comprising a liquid dielectric solution composed of a plurality of nanoconductors and a liquid dielectric solvent, said liquid dielectric solution disposed in a connection gap formed between at least one pre-synaptic electrode and at least one post-synaptic electrode;

a mechanism for providing a dielectrophoretic force for aligning said nanoconductors to form random neural network nanoconnections of a connection network between said pre-synaptic and post-synaptic electrodes within said liquid dielectric solution when an electric field is applied across said connection gap, such that said random neural network nanoconnections are strengthened or weakened according to said application of said electric field, a frequency of said electric or a combination thereof to provide said random neural network nanoconnections;

a gate located adjacent said connection gap in association with an insulator located between said gate and said connection gap, a logic circuit located to said gate, and wherein said at least one pre-synaptic electrode comprises a source and said at least one post-synaptic electrode comprises a drain, wherein said liquid state machine stores via patterns of neural activations of said physical neural network, a recent past history of said liquid state machine.

41. (Previously Amended) The liquid state machine of claim 40 further comprising at least one state-extracting neural circuit for extracting at least one state of said liquid state machine from said liquid state machine, said at least one state-extracting neural circuit comprising a perceptron that adjusts a synaptic weight of said perceptron in order to produce a desired output, said perceptron generating a linear mapping between at least one neural circuit within said liquid state machine and an output of said read-out neuron; and

wherein said liquid state machine comprises a collection of neurons, each neuron receiving time varying inputs from external sources as well as other neurons, wherein said neurons are randomly connected to each other via said neural network nanoconnections of said connection network, such that a recurrent nature of said neural network nanoconnections converts said time varying inputs into a spatio-temporal pattern of activations in said collection of networks, said spatial-temporal patterns of activations read out by a plurality of linear discriminant units.